A survey of the spiders (Arachnida, Araneae) of Chichagof Island, Alaska, USA

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ABSTRACT

A spider survey was conducted over the summer of 2003 on Chichagof Island, Alaska, USA. Based on this, as well as on data from a preliminary survey in 2002, and two subsequent visits, a preliminary list of 95 spider species is presented for the island. This survey resulted in 10 new species records for Alaska and 8 species not known to occur in British Columbia. The data were tested for completeness using Chao 1, Chao 2, bootstrap, and Michaelis-Menten species richness equations. The number of species observed fell within the variance for both Chao indicators but was below the other two estimators indicating that more species may still be found. Twenty-two micro and three macro habitats were defined in the survey. All data were submitted to the Nearctic Spider Database and cataloged on the Denver Museum of Nature & Science's website.

Key Words: Southeast Alaska, species richness estimators, species list, species diversity

INTRODUCTION

Spiders are a diverse but poorly understood animal group in the Pacific Northwest of North America (Bennett 2001). Little spider research has been completed in southeast Alaska (Mann & Gara 1980). Species lists are available for British Columbia (Thorn 1967; West *et al.* 1984, 1988; Bennett *et al.* 2006) and Yukon Territory (Dondale *et al.* 1997) but there are none for the southeast Alaskan archipelago.

Spider surveys may provide an effective means for measuring the impact of habitat degradation or land use change on biodiversity. Baseline studies involving spiders as biological indicators have been conducted elsewhere; e.g. Allred (1969) and Allred & Gertsch (1976) documented spider diversity in Arizona and Utah after new power plant installations and in Nevada at the Nevada Nuclear Test Site. The need for spider species lists for use in conservation decision making has also been expressed (Skerl 1999). In addition, spiders may play roles in the control of destructive insects (Jennings & Pase 1986; Maloney *et al.* 2003).

Southeast Alaska provides important resources for three major industries: logging, fishing, and tourism. Biodiversity surveys provide important baseline information to help land resource managers understand and monitor environments utilized by these industries. Spiders may provide a useful survey option because of the relative ease with which they can be collected, preserved, and identified.

The objective of this study was to document the spider fauna of northern Chichagof Island, Alaska in a manner that can be replicated on other islands in the southeast Alaskan archipelago in an attempt to assemble a comprehensive spider fauna list for the area. The preliminary spider species list and other information provided here are meant to be resources for future surveys in the area and relevant biogeographic and taxonomic studies.

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MATERIALS AND METHODS

Study Site. The study site is located at 58.10° N 135.42° W in southeast Alaska on the northeast corner of Chichagof Island, approximately 100 km west of Juneau (Fig. 1). The study area is located within the Tongass National Forest, Sealaska Corporation land, Huna Totem Corporation land and Alaska State lands. The study site consisted of an area of roughly 86,765 ha located around the town of Hoonah, Alaska (Fig. 1), and is characterized as northern temperate rainforest dominated by western hemlock (*Tsuga hetrophylla* (Raf.) Sarg.). The area around Hoonah and northward to Gustavus is in a slight rain shadow for southeast Alaska with an average annual rainfall of 130 cm (*versus* Juneau at 250 cm). The area is dominated by steep, abruptly ascending mountains and narrow valleys left by recent glacial activity with elevations from sea level to over 1,180 m.

In 2002 a preliminary survey was conducted and three general macro-habitats and 22 micro-habitats were defined (Table 1). The micro-habitats were used for comparing similar sites in the study area and for expanding search areas if few or only immature spiders were found at a given site. Each of the 22 micro-habitats is included in one of the three macro-habitats: shrubby skree or logged areas, open muskeg meadows, and densely treed old growth forests. The shrubby areas are dominated by several species of *Vaccinium* L. and *Rubus* L. and devil's club (*Oplopanax horridum* (Smith)) growing to over 2 m in height. The muskeg areas consist of low shrubs under 0.5 m tall (*Kalmia microphylla* (Hook.) Heller) and *Andromeda polifolia* L.) and grasses, with pools or slow moving streams. The old growth areas consist mainly of hemlocks (*Tsuga hetrophylla* and *T. mertensiana* (Bong.) Carr.) with some Sitka spruce (*Picea sitchensis* (Bong.) Carr.) and yellow cedar (*Chamaecyparis nootkatensis* (D. Don) Spach) intermixed and usually have few shrubs in the understory and a closed canopy.

There are no protected areas within the study site and substantial clear-cut logging on blocks ranging from 0.08 to 40.00 ha occurred on the island from the early 1980's until 2004. During the survey period, the resulting second growth areas were relatively young and differed little in structure from the naturally occurring shrubby skree areas.

Data Collection. All specimens were collected by the author during the period 22 April to 24 August 2003 using one of six methods: beat sheeting, sweep netting, sifting moss, head-lamping, pitfall trapping and casual collection. Because of the density and thickness of the forests and clear-cut areas an alternative method of sweeping/beating was used in those areas. This method consisted of grabbing either branches or the top of a tree and stuffing it into the sweep net, then beating the branch or treetop in the net. This method was also used in shrubby areas where the vegetation was too dense to sweep or beat. The head-lamping method consisted of using a head-lamp or other light source and looking both up and down for eye shine and webs after dark. Specimens were deposited directly into 75% ethanol for preservation. Each collection occurrence consisted of one method and was conducted for one half hour, although multiple collection occurrences may have occurred in a day or at a site.

Pitfall traps were sets of 230 ml plastic cups placed in the ground with the lip of each cup level with the ground surface. Each set consisted of 10 cups placed 1 m apart in a line. The traps were filled with 30-60 ml of propylene glycol as a preservative. Traps were covered only if rain was imminent. Pitfall trap specimens were collected every two days to one week (dependant upon rainfall) then sorted, washed and stored in 75% alcohol.

Because of the difficulty of identifying juvenile spiders only adults were identified and used for the analyses. Linyphiidae

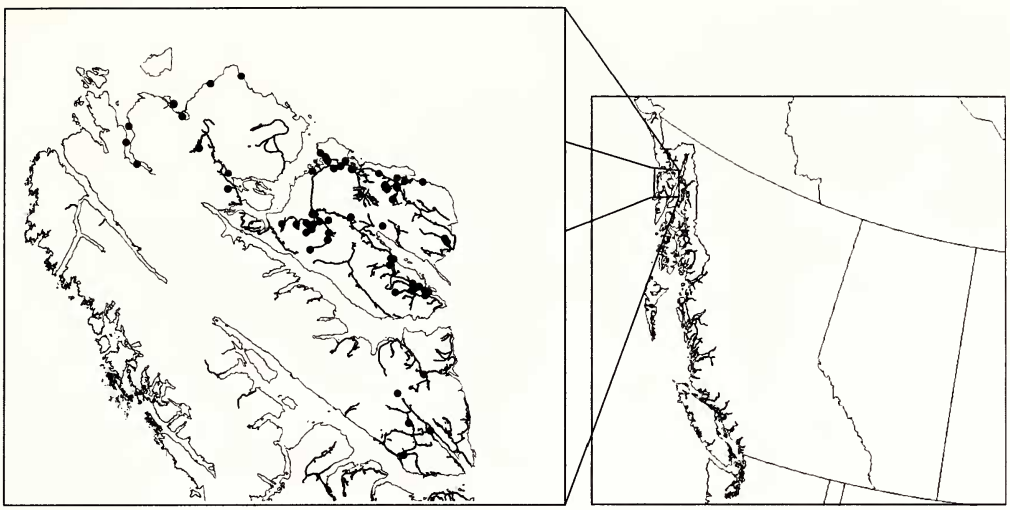

Figure 1. Spider collections sites on Chichagof Island, Alaska, USA, 2002-2005. Each point may represent more than one habitat or collection occurrence.

were identified by D. J. Buckle (Saskatoon, Saskatchewan), Philodromidae and Thomisidae were identified by F. X. Haas (Denver, Colorado). All other spiders were identified by the author using Roth (1993) or Ubick *et al.* (2005) and included references. Voucher specimens were deposited at the Denver Museum of Nature & Science. Nomenclature follows Platnick (2006). See discussions in Crawford (1988), Buckle *et al.* (2001) and Ubick *et al.* (2005) regarding linyphiid nomenclature.

Statistical analysis. Species richness was estimated using Chao 1 (Chao 1984), Chao 2 (Chao 1984, 1987), bootstrap (Smith & van Belle 1984), and Michaelis-Menten (Raaijmakers 1987) estimators following Coddington *et al.* (1996). The Chao 1 estimator is a non-parametric equation using relative abundance data; the Chao 2 estimator is also non-parametric but uses presence-absence data. The bootstrap estimator uses incidence data and the Michaelis-Menten model contrasts sampling effort data and number of species observed. See Magurran (2004) for discussion of the various usage and accuracy issues associated with these estimators. Species accumulation curves were plotted using EstimateS (Version 7.5, Colwell 2005).

Three of the richness equations, Chao 1, Chao 2, and bootstrapping require collection occurrence data, which is defined as each separate occurrence in which spiders were collected. For the sampling effort aspect of the Michaelis-Menten equation each collection occurrence (other than casual and pitfall trapping) consisted of one-half hour (as described above). Because the movements of spiders are not well understood, statistical analysis of each pitfall trap occurrence was arbitrarily attributed one hour of sampling effort following Coddington *et al.* (1996) (although Coddington used leaf litter samples and a Tullgren-funnel). Specimens collected with methods other than those described above were considered to be casual occurrences and were each attributed five minutes of time.

Specimen data were submitted to the Nearctic Spider Database (http://canadianarachnology.webhop.net) and catalogued on the Denver Museum of Nature & Science website (www.dmns.org/spiders/default.aspx).

Habitat and collection method were used to determine general species habitat associations: arboreal, ground-dwelling, or other. These determinations are speculative but may be helpful in locating species in similar environments.

Table 1.
Habitats sampled for spiders on Chichagof Island, Alaska, 2002-2005.

Microhabitat number	Macro-habitat	Physical description	Water	Canopy
1	Shrubby	Shot rock, buildings	None	Open
2	Shrubby	Sitka alder, snake grass	Pooled	Moderate
3	Open	Grass only	Running	Open
4	Open	Grass only	Pooled	Open
5	Open	Low shrubs and grass	Pooled or none	Open
6	Treed	Mossy, shrubby	None	Moderate
7	Treed	Mossy, few shrubs	None	Moderate
8	Treed	Mossy, few shrubs	None	Closed
9	Open	Shot rock, quarry	Temporary pools	Open
10	Shrubby	Shrubby	None	Moderate
11	Shrubby	Shrubby, no alder	None	Open
12	Shrubby	Shrubby, alder present	None	Open
13	Open	Muskeg, shrubs, various water, above 500m	Pooled, running	Open
14	Open	Grassy meadows, few shrubs, no water, above 500m	None	Open
15	Open	Rocky, shrubby, coastline debris	Tidal	Open
16	Open	Tall grass	Tidal	Open
17	Treed	Shrubby, treed	Running	Moderate to closed
18	Treed	Few shrubs, low grass	None	Closed
19	Shrubby	Tall grass, shot rock	Temporary pools	Open to moderate
20	Treed	Marshy, tall grass	Pooled	Moderate to closed
21	Shrubby	Shrubby, treed, mossy	None	Moderate
22	Open	Tall grass	Pooled	Open

RESULTS AND DISCUSSION

A total of 1,239 adult spiders representing 16 families, 68 genera and 95 species (Appendix 1) was collected and identified from 103 collection occurrences.

The 2003 survey consisted of 43 hours of collection time accumulated over 40 days during the period 22 April to 24 August and produced 93 of the 95 total species observed. *Agnyphantes arboreus* (Emerton) and *Tetragnatha extensa* (Linnaeus) were collected in 2002 but not subsequently. Total survey time including travel and sorting of pitfall traps was 150 hours. Additionally the site was surveyed casually in 2004 and 2005 but no further species were added to the list.

Based on the habitat and method of collection; 49 species were classified as ground-dwelling and 34 species as arboreal. Twelve species occurred in both general habitat types. Fifty-four species (56%) and 521 of all spiders (42%) collected

were linyphiids. Fifty-one of the linyphiid species were collected in pitfall traps, 13 were collected using others methods as well.

Expected number of species resulting from all species accumulation equations was higher than the observed number of 95 species, indicating that further sampling should result in more species (Figure 2). However, the observed number fell within the variance for both the Chao 1 and Chao 2 equations (97 ± 7.48 and 104.45 ± 11.58 respectively). The Michaelis-Menten model and the bootstrapping methods predicted 130.72 species and 106.35 ± 7.00 species respectively.

Species of interest. *Diplocephalus sphagnicola* Eskov 1988, a Siberian spider, was collected for only the third time in North America. Several specimens of a described but unnamed species of *Centromerus* Dahl, previously known only from one damaged male collected at Terrace, BC in 1920 (van Helsdingen 1973) were collected. This survey produced records of 10 species not previously reported from Alaska (D. J. Buckle, unpublished data) and eight species not known to occur in British Columbia (Bennett *et al.* 2006) (Appendix 1). Two of these records, *Maro amplus* Dondale & Buckle and *Walckenaeria redneri* Millidge, are the first for either area.

All of the 13 undetermined species are linyphiids, five are female erigonines (currently unidentifiable), two are known but undescribed species (*Porrhomma* sp. #1 and *Centromerus* sp. #1), five are in genera in need of revision (*Agyneta* Hull, *Eularia* Chamberlin and Ivie, *Oreonetides* Strand, *Pityohyphantes* Simon, *Tapinocyba* Simon) and could not be placed, and one species of *Walckenaeria* could not be determined. Several larger families were represented by surprisingly low numbers of species: only a single female philodromid, *Tibellus oblongus* (Walckenaer) and two females of a single salticid species, *Evarcha proszynskii* Marusik & Logunov, were collected.

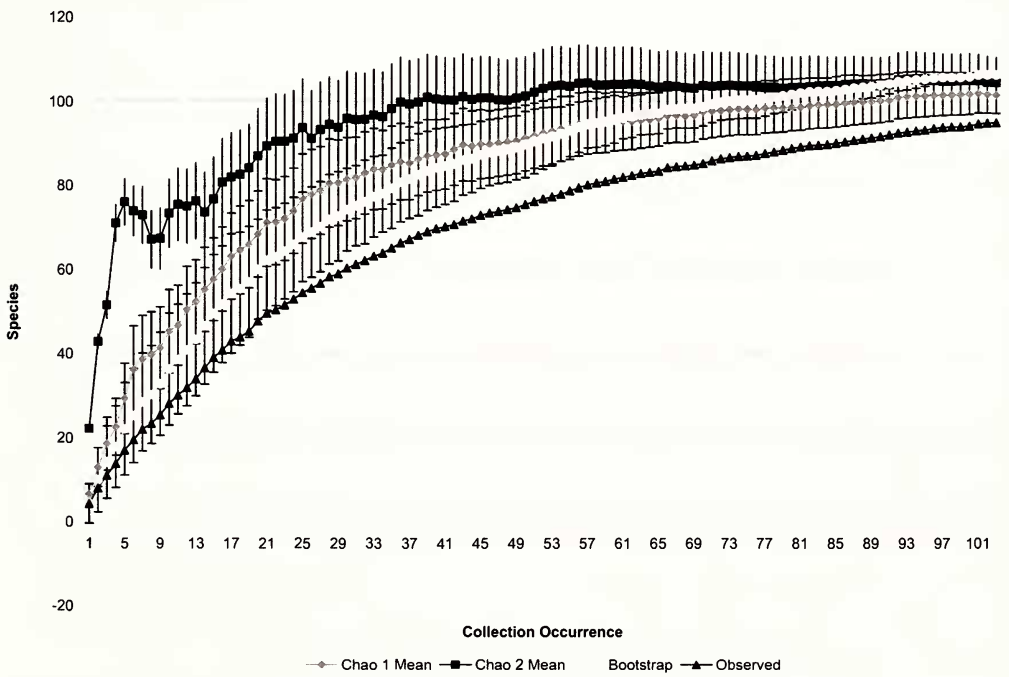

Figure 2. Species accumulation curve for spiders sampled using all methods described in text on Chichagof Island, Alaska, USA, 2002-2005 and estimates of Chao 1, Chao 2 and bootstrapping results from statistical analysis using EstimateS (Version 7.5, Colwell 2005). Vertical bars indicate computed variance. Michaelis-Menten analysis results are not displayed.

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APPENDIX 1

Spider species list and collection data for Chichagof Island, Alaska USA, sorted alphabetically by family, genus, and species. Habitat numbers refer to Table 1. "*" indicates a new record for Alaska; "**" indicates a species not listed for British Columbia. Detailed collection data for each species is accessible on the Nearctic Spider Database (http://canadianarachnology.webhop.net) and the Denver Museum of Nature & Science website (www.dmns.org/spiders/default.aspx).

Family/Species	Months Adults Found	Collection Method	Habitat Number	Males	Females
Amaurobiidae					
Callobius pictus (Simon, 1884)	May-Sept.	casual, headlamp, pitfall	1, 6, 8	6	11
Cybaeopsis wabritaska (Leech, 1972)	April-June	headlamp, pitfall	2, 3, 4, 5, 13, 22	65	6
Araneidae					
Araneus saevus (L. Koch, 1872)	Aug.	casual	1	1	1
Araneus trifolium (Hentz, 1847)	July	casual, sweep	4, 5, 22		3
Araniella displicata (Hentz, 1847)	May-June	beat, sweep	4, 5, 20, 22	2	8
Cyclosa conica (Pallas, 1772)	May-June	headlamp, sweep	1, 4, 5, 21, 22	3	5
Larinioides patagiatus (Clerck, 1757)	April-May	headlamp, sweep	1, 4, 5		5
Parazygiella dispar (Kulczyn'ski, 1885)	May & Aug.	casual, headlamp	1	4	3
Clubionidae					
Clubiona pacifica Banks, 1896	April-Aug.	headlamp, sweep	1, 4, 5, 19, 22	8	6
Clubiona trivialis C. L. Koch, 1843	May-July	beat	4		6
Cybaeidae					
Cybaeus reticulatus Simon, 1886	April-May & Aug.-Oct.	casual, headlamp, pitfall	1, 2, 3, 5, 6, 7, 8, 10, 21	34	37
Dictynidae					
Dictyna brevitarsa Emerton, 1915	May-July	beat, sweep	4, 5, 13, 22		11
Dictyna major Menge, 1869	June-July	sweep	4, 5	10	7
Gnaphosidae					
Micaria pulicaria (Sundevall, 1831)	May-June	casual, sweep, pitfall	1, 4, 5		3
Sergiolus montanus (Emerton, 1890)	May	casual	1		1
Hahniidae					
*Antistea brunnea (Emerton, 1909)**	April-July	pitfall	3, 4, 5, 8, 22	1	34
Dirksia cinctipes (Banks, 1896)	May & Sept.	casual, sweep	8, 15	1	1

APPENDIX 1 *(continued)*

Family/Species	Months Adults Found	Collection Method	Habitat Number	Males	Females
Hahniidae *(continued)*					
Hahnia cinerea Emerton, 1890	May-June	pitfall	3, 4		3
Neoantistea magna (Keyserling, 1887)	April	pitfall	2		1
Linyphiidae					
Agnyphantes arboreus (Emerton, 1915)	July	casual, sweep	4, 5, 15	1	1
*Agyneta olivacea (Emerton, 1882)**	May-June	pitfall	3, 4, 5	15	
Agyneta sp #1	June	pitfall	4	2	2
Aphileta misera (O. Pickard-Cambridge, 1882)	June	pitfall	4, 5	1	
Bathyphantes brevipes (Emerton, 1917)	May & Sept.	beat, headlamp, pitfall	1, 6, 15, 18, 22	2	2
Bathyphantes pallidus (Banks, 1892)	May-June	pitfall, sweep	3, 21	1	2
*Centromerus sp #1**	April-May	pitfall, sift, sweep	3, 5, 15	2	2
Ceraticelus atriceps (O. Pickard-Cambridge, 1874)	May	pitfall	5		1
*Ceratinella acerea Chamberlin & Ivie, 1933**	April-May	pitfall, sift	8, 15		2
Ceratinella ornatula alaskana Chamberlin, 1948	May	pitfall	3	3	
Ceratinops inflatus (Emerton, 1923)	May	pitfall	7, 8	15	
Collinsia ksenius (Crosby & Bishop, 1928)	April-June	sweep	17		3
*Diplocephalus sphagnicola Eskov, 1988**	April	pitfall	3	1	1
Erigone aletris Crosby & Bishop, 1928	May-Aug.	sweep	4, 14, 16, 19	6	9
Erigonine sp #1	May	pitfall	7, 8		6
Erigonine sp #3	June-July	pitfall	4, 5, 22		3
Erigonine sp #4	June	pitfall	4, 5		2
Erigonine sp #7	May-June	pitfall	4, 8		2
Erigonine sp #8	May-June	sweep, pitfall	3, 4, 15		3
Eulaira sp #1	May	pitfall	5	1	
*Grammonota subarctica Dondale, 1959 **	April-July	pitfall	3, 4, 5, 22	3	129
*Hybauchenidium cymbadentatum (Crosby & Bishop, 1935)**	April-June	pitfall	3, 4, 5		8
Kaestneria pullata (O. Pickard-Cambridge, 1863)	April-July	casual, pitfall, sift, sweep	3, 4, 5, 11, 15, 21		8
Linyphantes pualla Chamberlin & Ivie, 1942	May	pitfall	8		1
Maro amplus Dondale & Buckle, 2001 & **	May	pitfall	4, 5	2	2
Meioneta simplex (Emerton, 1926)	June	pitfall	4, 5	3	
Microlinyphia dana (Chamberlin & Ivie, 1943)	May-June & Sept.	sweep	2, 4, 5, 15, 16, 19, 21, 22	13	37

APPENDIX 1 *(continued)*

Family/Species	Months Adults Found	Collection Method	Habitat Number	Males	Females
Linyphiidae *(continued)*					
Mythoplastoides erectus (Emerton, 1915)	April-July	pitfall, sift	7, 8	1	3
Neriene digna (Keyserling, 1886)	April-June	casual	1	4	5
Oedothorax alascensis (Banks, 1900) **	April-May	sweep, beat	6, 15, 17		2
Oedothorax trilobatus (Banks, 1896) **	April-May	pitfall	3	6	
Oreoneta brunnea (Emerton, 1882)	May-June	pitfall	3, 4, 5	24	8
*Oreonetides rectangulatus (Emerton, 1913)***	April-May	pitfall	3	3	
Oreonetides sp #1	May	pitfall	3	1	
Pelecopsis sculpta (Emerton, 1917)	May-July	pitfall	4, 5	9	4
Pityohyphantes sp #1	April-Aug.	casual, beat, head-lamp, sweep	1, 4, 5, 19, 21		10
Pocadicnemis pumila (Blackwall, 1841)	April-June	pitfall, sift	3, 4, 5, 11, 15, 21	12	5
Porrhomma sp #1	June	sweep	4, 5		1
*Satilatlas insolens Millidge, 1981***	May	pitfall	3	2	
Sciastes truncatus (Emerton, 1882)	April-May	pitfall	7	3	
Sisicotus nesides (Chamberlin, 1921)	April-June	pitfall, sift, sweep	1, 5, 6, 7, 8, 18, 22	18	20
Sisis rotundus (Emerton, 1925)	April-May	pitfall	3, 8	1	1
Symmigma minimum (Emerton, 1923)	May-June	pitfall	4, 5, 8	2	
Tachygyna ursina (Bishop & Crosby, 1938)	May-June	beat, sweep	4, 5, 18		4
Tapinocyba dietrichi Crosby & Bishop, 1933	May-July	pitfall, sift	6, 8	4	2
Tapinocyba sp #1	May-June	pitfall	4	4	1
Tenuiphantes zelatus (Zorsch, 1937)	April-June	casual, pitfall sift	6, 7, 8, 22	2	6
*Walckenaeria columbia Millidge, 1983**	April-June	pitfall, sift	7, 8, 13, 21	2	2
Walckenaeria cornuella (Chamberlin & Ivie, 1939)	April-May	sweep, pitfall	1, 7, 8, 9, 18	5	3
Walckenaeria directa (O. Pickard-Cambridge, 1874)	May-June	pitfall	3, 4, 5	7	3
*Walckenaeria exigua Millidge, 1983**	June	pitfall	4	4	
Walckenaeria redneri Millidge, 1983 & **	April-May	pitfall, sweep	3, 4, 5, 16	18	3
Walckenaeria spiralis (Emerton, 1882)	June	pitfall	4, 5	3	3
Walckenaeria sp #1	Oct.	pitfall	8		1
*Wubana pacifica (Banks, 1896)**	April-May	pitfall	7	2	
Lycosidae					
Alopecosa aculeata (Clerck, 1757)	May-June	pitfall	4	2	
Pardosa dorsuncata Lowrie & Dondale, 1981	April-June	headlamp, pitfall, sweep	1, 2, 3, 4, 5, 16, 18, 20, 21, 22	45	31

APPENDIX 1 *(continued)*

Family/Species	Months Adults Found	Collection Method	Habitat Number	Males	Females
Lycosidae *(continued)*					
Pardosa moesta Banks, 1892	May-July	sweep, pitfall	3, 4, 5, 18, 21	72	30
Pirata piraticus (Clerck, 1757)	June-July	casual, pitfall, sweep	4, 5, 21, 22	13	5
Trochosa terricola Thorell, 1856	April-June	casual, pitfall, sweep	3, 4, 5, 16	36	14
Philodromidae					
Tibellus oblongus (Walckenaer, 1802)	June	sweep	4, 5		1
Pimoidae					
Pimoa altioculata (Keyserling, 1886)	May & Aug.	casual, headlamp	1, 17	2	3
Salticidae					
Evarcha proszynskii Marusik & Logunov, 1998	June	sweep	4, 5		2
Tetragnathidae					
Tetragnatha extensa (Linnaeus, 1758)	July	sweep	4, 5	1	
Tetragnatha laboriosa Hentz, 1850	May-July	beat, sweep	4, 5, 11, 18, 19, 21, 22	37	46
Tetragnatha versicolor Walckenaer, 1842	May-Aug.	casual, sweep	4, 5, 19	7	5
Theridiidae					
Robertus vigerens (Chamberlin & Ivie, 1933)	April-June	pitfall, sweep	3, 4, 5, 18		9
Rugathodes sexpunctatus (Emerton, 1882)	April-July	beat, casual, sweep	2, 4, 5, 11, 15, 16, 18, 19, 20	9	30
*Theonoe stridula Crosby, 1906***	April-May	pitfall	3	2	
Theridion saanichum Chamberlin & Ivie, 1947	May-July	sweep	4, 5	3	
Thomisidae					
Bassaniana utahensis (Gertsch, 1932)	Aug.	headlamp	1		1
Misumena vatia (Clerck, 1757)	May-July	sweep	5, 21, 22	3	1
Ozyptila pacifica Banks, 1895	April	pitfall	3	4	
Xysticus luctuosus (Blackwall, 1836)	April-June	pitfall	4, 5, 21	12	
Xysticus pretiosus Gertsch, 1934	May & Sept.	casual, headlamp	1	3	
Uloboridae					
Hyptiotes gertschi Chamberlin & Ivie, 1935	Aug.-Sept.	casual, headlamp	1, 7		3